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ORDNANCE.—*Developments in artillery during the war.*[1] JOHN HEADLAM, Major-General, in charge of the British Artillery Mission. (Communicated by L. J. Briggs.)

It is a trying ordeal for a soldier with no pretension to scientific knowledge to address such an audience as this, particularly when he has to commence with an apology for ignorance on that part of his subject which is of most interest at the moment. I must confess to you, gentlemen, that I have not even a theory to advance regarding the Paris gun, and I can only throw myself on the mercy of the court! But I take courage from your well-known kindness so constantly extended to British officers. And if I can not claim to be one of those artillerymen who have invaded the domains of science, I have learned, as an artillery commander in the field, how much we owe to the scientists who have devoted their talents to the solution of the problems which confront us. I think therefore that I may be able to tell you something of the development of artillery during this war, from the user's point of view, which may be of interest. The subject is so vast that it would be quite impossible even to touch on, much less to deal adequately with, all the directions in which these developments have taken place, even if I were to devote myself entirely to the science of artillery.

But this is not everything. To engage the right target from the right place, with the right guns, this is the artilleryman's

[1] A lecture given before the Washington Academy of Sciences on April 3, 1918.

art, without which his *science* is half wasted. In artillery, more than in any arm of the service, tactical and technical considerations are most intimately connected. I shall try to show how the changes in tactics affect technical matters and how the demands of the soldier may upset the plans of the scientist, and I hope that I shall be able to make you understand that the entry of science into war has in no way taken away the glamour of romance however much it may have increased its horror.

I shall not trouble you with any reference to organization. You must accept it from me that every operation in this war has confirmed the necessity for a carefully elaborated scheme for the employment of concentrations of artillery, involving a methodical allotment of tasks from the outset, and largely depending for its successful execution on an effective chain of artillery command.

Field artillery material. It will, I think, be advisable to commence with some brief reference to the various types of artillery employed in the field, without attempting to go into detail regarding any particular nature. Taking *field* artillery first, we stand practically where we were. At one time an idea got abroad that the days of field artillery were numbered, that it had been supplanted by the "heavies." This was a very dangerous heresy, but it is dead. The field artillery is as firmly established in its position as it ever was, the proportion of guns to bayonets has altered little, and the material has changed least of all. The Germans still have their old field gun, made as a breech loader in 1896 and converted into a quick firer in 1906. Our own 18-pounder, which was brought into the service at the beginning of this century, immediately after the South African War, is still in our belief admirably suited for its work. It is no secret that the American artillery has adopted a field gun designed and made by those admirable gunners, the French, in the nineties of the last century.

Shrapnel versus high explosive. But there are two points in connection with field artillery material on which a real difference in opinion and practice exists.

The first is the relative values of shrapnel and high explosive shell. On this the French and ourselves are the great protago-

nists of the rival schools. Their 75-mm. is primarily designed for the rapid fire of high explosive shell and its "rafales" did marvels in throwing back the first great German advance on the Marne. The English, as befits the country of the inventor, General Shrapnel of the British Army, have always been great shrapnel adherents; our 18-pounder was designed as a shrapnel gun, and has undoubtedly the most powerful shrapnel in existence. I admit that we carried this too far in having no high explosive at all, and you may possibly recall the great outburst of indignation caused by some so-called "revelations" in the press regarding the shortage of high explosive shell in 1915. The question now is not of there being enough high explosive, but of getting the artillery to use the proportion that the manufacturers would like to produce. We saw the effect of our shrapnel on the German infantry in 1914, and we have not forgotten it.

The second is the advisability of including howitzers in field artillery. Here again we join issue with our French friends, who hold that the lowest caliber for the howitzer is the 6-inch. But we know what our howitzers have done for us, and as I see again in memory the many fields on which our 4.5-inch rendered such yeoman service, ever since they first came into action among the slag banks and pitheads at Mons, I can scarcely imagine how we should have fared without them. And here I know that our infantry would back me up.

Use of heavy artillery in the field. When we turn to heavy artillery, in which I include all natures other than field, the story is one of almost miraculous progress. Broadly speaking, it may be said that heavy artillery formed no part of the equipment of modern armies at the commencement of the war. This is not strictly true, for the Germans had a battalion of 6-inch howitzers in each corps, while we had a battery of 60-pounders in each division. But the use of heavy artillery in the field was no new thing, though the whole world gasped in amazement when the Germans brought up their big siege pieces on the Aisne. In modern days, it had been done with success by the Boers, who used the 6-inch guns taken from the fortifications of Pretoria with success against us on many occasions. As soon as Port Arthur fell

the Japanese brought their 11-inch howitzers to join the field army in Manchuria, and the mountings of some of your coast defense guns on their way to join the field army in France are modeled on those which our sailors improvised to carry their ship guns across the South African veldt.

Proportion of howitzers. In field artillery we have seen that controversy raged around the inclusion or not of howitzers at all. In heavy artillery all are agreed that both are necessary, but opinion is at variance as to the proportion of each. Here again we find ourselves on the side of the Germans while the French are, or were, all for the gun. But in this matter as in so many others, friendly discussion, and the exchange of experience, has brought us very much to the same point of view. The whole thing really turns on whether howitzers should be used for counter battery work or confined to bombardment. We hold that the howitzer is more accurate against such a target as an enemy's battery; that it is more mobile for the same weight of shell; that its fire can be more easily observed, especially from an aeroplane; that it has a longer life; and that it is easier to place, not only because it can be tucked away into hollows of the ground where it would be impossible to use a gun; but also (and this is a curious development of this war of masses), because it can be used in crowded areas. I have often seen our big howitzers in action in the midst of a mass of congested traffic around some depot of supplies, with troops moving in every direction, wagons loading up with stores, and so forth, under their very muzzles, where the blast of a gun would have swept everything away in front of it. But while controversialists are marshalling such arguments it looks as if the ground would be cut away from under their feet by the disappearance of the distinction between gun and howitzer! The length of the howitzers has gradually grown from 13 calibers to 17, and now in some of the latest to over 20, while the use of varying charges either to reduce the wear, or to allow of the employment of curved fire, is gaining ground for guns.

Trench mortars. At the other end of the scale we have trench mortars, again only a revival of a weapon well known a century

or more ago. They also were used extensively by the Japanese in Manchuria, but I am afraid that the artillery as a whole was rather inclined to scoff at them when they first appeared. Those days, however, soon passed. It was recognized that in the form of trench mortars, we could increase our strength for bombardment by utilizing *material and labor not good enough for guns.* The German trench mortars, for instance, were chiefly made by a firm famous the world over for its cream separators! What distinguished officers at one time called "tin pot artillery" thus rose gradually in favor, until in Italy it took the place of horse artillery as a *corps d'élite.* But in those days we were shorter of guns and ammunition than of men. Now the position is reversed. Trench mortars are terribly expensive in men, and more especially in officers, and so just when the material is being perfected, the mortars are dropping to some extent out of use. It is just one of those changes which must be so baffling to the civilian who tries to help us.

Increase in range. With all natures, guns and howitzers, field, heavy, and trench mortars, there has been a continual cry for range, and still greater range. This has been due to many causes, chiefly tactical, but principally to the extension of field of fire given by aeroplane observation. The various expedients which have been resorted to to meet this demand are interesting. In the first place there was the simple lengthening of the howitzers, and the bringing into the field of the long high-velocity naval and coast-defense guns. Then there came the various alterations in form of shell, the general feature of all of which is a great lengthening of the ogive (the pointed nose of the projectile). The radius of curvature of the ogive has been increased from 2 to 6, and in some cases to 8 calibers, but the most notable form is the French "Obus D," so called after General Desailleux, the officer chiefly responsible for the design, and usually designated by us as the "stream line" form. Our experience with this form has not been very encouraging, but it is admitted that the slope of the base has a very important bearing, and must be determined for each nature, and I may mention as an instance of the close cooperation existing between us, that the French have recently

designed a shell for trial in our guns with which we hope to get better results. The "false head," another form of the same idea, is largely used by French and Germans in the heavier long range guns, but again it is not so popular with us. It introduces considerable complication in supply and fitting and is suspected of being a possible cause of "prematures." No doubt with the extension of the use of longer-headed shell, the necessity for false heads disappears to a great extent. But I am by no means satisfied that they have not great possibilities when used with shell designed from the commencement for them.

Long-burning fuses. The most difficult problem in connection with range is the provision of a time fuse which will be reliable for long range fire. We should use shrapnel far more than we do, if we could get a good time fuse, reliable at long ranges. Here is an opportunity if ever there was one for the scientists. As you probably know, the fuses in the service now depend on the burning of a train of composition, which must be liable to many inaccuracies, especially when you consider the conditions under which it has to be kept on service. Mechanical fuses have been known for long, and we did our best to encourage inventors nearly twenty years ago, but such fuses only came into real use last year when it was noticed that the Germans were making uncommonly accurate practice at our balloons, at ranges up to over 20,000 yards. Early in the summer we got specimens of their fuse, which turned out to be a clock-work fuse designed in 1916. The Academy of Sciences will be interested to hear that they were at once handed over to the Cambridge Physical Laboratory—it would perhaps be indiscreet to proceed further with my revelations.

Use of guns at close quarters. But if the tendency is always to increase the range of our guns, do not think it is with the object of keeping them back. Far from it, for even if guns are as a rule further apart than they were in the old wars, the men who direct the guns are closer than they were even in Napoleon's time, and there is still as much room as ever for the display of personal enterprise and gallantry. But as a matter of fact, just as this war has seen the revival of hand-to-hand fighting with the bayonet and

the butt, so it has seen guns pushed into closer ranges than has occurred for a century at least. On many occasions I have known individual field guns put within 200 yards of the enemy's trenches. This was of course for some special task, such as breaching a parapet or knocking out some particularly obnoxious "nest" of machine guns. With time, ingenuity, and courage, a gun can be got almost anywhere, and the effect of its fire at such ranges is very marked, while its presence affords immense encouragement to the infantry. Great care must of course be taken in working out the preliminary arrangements, and in one case I may mention where a gun had to be brought up over the open, it was moved at night under a canopy, like a dignitary of the Church in high festivals, and the gunners who carried the canopy were trained to drop it on the gun whenever a flare went up. This gun fired its 100 rounds at a range of 70 yards in nine minutes, completely destroying its objective, and the detachment then, strictly against orders, joined in the assault.

Another case I know forms rather a touching story. When I was on the Italian front beyond Gorizia in 1916 I happened one day to see a gun very cleverly concealed in the front line, to be used in much the same way. Curiously enough I met last year the commander of the corps to which this gun belonged, and talking one day he asked me if I remembered it. He said he had been going around after me, and the noncommissioned officer in charge had told him how an English general had shaken his hand and congratulated him on being in the place of honor. Poor fellow, he did his work with complete success next day, but he and all his men were killed.

Increase of heavy artillery. But, gentlemen, I am not sure that the real romance of artillery in this war does not lie in the efforts made to furnish us with the material we so urgently needed. At the beginning, as I have said, we had one battery of "heavies" per division, or 24 guns in the whole of our "contemptible little army." On the Aisne we got our first siege howitzers of 6-inch caliber, and I had placed under my command there the same battery which as a young staff officer I had guided to its first position against the Boers at Pardeberg. During the winter of 1914, a

few more heavy guns and howitzers began to arrive, but by midsummer of 1915, we had only about 70 all told. The summer of 1916, however, saw this number increased just tenfold, while by last summer it had been more than doubled again. How was this done? In the first place by utilizing every gun, whether designed for a fort or a ship, that we could lay hands on. The mounting of such guns, for work in the field, either on railway trucks or carriages, has given great scope for ingenuity, especially as the task has become more and more complicated by the necessity for economy in metals and in skilled labor. But all along the great consideration has been *time*, and this of course has been especially true of new manufacture. It is to that element of time that I would like to draw your special attention, because it is one which, if you will pardon me for saying so, the scientist is perhaps a little inclined to overlook. It is only natural that he should be absorbed in the perfecting of his design, but the poor soldier facing the German can not wait for the fairy tales of science and the long results of time, but wants something, anything, and quickly, that will shoot.

National efforts. And then Mr. Lloyd George, like a new Peter the Hermit, led a crusade to stir up the people at large to the manufacture of guns and shells. We perpetuated designs which we knew to be out of date. We adopted, with our eyes open, new designs which were in many points based on considerations of facility of manufacture, rather than of perfection, and we risked the omission of many of the regular stages of trial hitherto considered essential. It was a gamble, but it was the only way to get the numbers required, and it was justified by success. In this connection I may perhaps mention a most remarkable instance of adherence to antiquated pattern, in order to avoid any delay to output, afforded by the Germans. The outbreak of war found Germany, as I have already mentioned, with an obsolescent field gun, but as I personally discovered in the battle of the Somme, she directed all her energies, not to remedying its defects, but to developing production. I happened by accident to examine there two captured guns which were standing side by side. One, No. 40, had been made twenty years before and

converted from breech loading to quick firing; the other, No. 6173, had only been made the previous year, but there was not a rivet's difference between them; only, in the new gun, time had been saved by omitting engraving the Imperial cipher on the breech!

Ammunition. As with the guns, so with the ammunition, but perhaps to a still greater extent, production has been the great problem, for from early in the first autumn of the war our stocks of ammunition were practically exhausted, and we gunners had over and over to turn a deaf ear to the calls for help from our almost exhausted infantry. Everything possible was done to expedite output. National shell factories were set up all over the country, for the smallest shop could at least make 18-pounder shrapnel bodies, and delicate women toiled long hours at the lathes. We adopted designs which were not the best but which were the easiest to make, and then faced the danger of "prematures."

Prematures. This bursting of guns by the premature explosion of the shells is almost inevitable when one has to depend on hurried and unskilled production: it is one of the risks which must be run when shells have to be rushed out to the front. But the loss of guns and men may be serious, and it is always a trying ordeal to the artillery. The French with their large expenditure of high explosive shell were the first to suffer severely from it. I remember seeing many of their wrecked 75's when we were fighting side by side at Ypres at the time of the first gas attack, but they bore it with the calm fortitude which has been their attitude through all these long years of trial, and when our own time came, their experts placed all their experience at our disposal, and rendered us invaluable assistance in getting through our trials, and I would like especially to mention here the names of General Gossot, an artilleryman who has gained more than a national reputation as a contributor to science, and General St. Claire Deville, whose name is a household word in France as "the father of the seventy-five." It will do no harm now, and may do good, to tell you how serious our position was at one time. [The ratio of prematures, at first irregular, then rapidly decreasing, was shown by tables.]

There will always be prematures, and loss of life from them, while high explosive shells are used, but we look to science to apply its methods to the investigation of every case, and to guard us, as far as human ingenuity can, against them.

But what did we gain by accepting these risks? The average number of tons of ammunition fired away per week in France will probably be the simplest way of putting it. [The figures, in tons per week, showed the immense increase in output attained since the war began.]

Economy of materials. It was not until our production was assured that we were able to set ourselves to improving our designs, and then came the necessity of economizing materials, to dampen the enthusiasm of our designers again. We have had to reduce the capacity of our favorite 18-pounder shrapnel to allow of the use of lower grade steel. We have had to replace our well tried propellant, cordite, by nitro-cellulose; to reduce the percentage of T.N.T. in our explosives; to let brass displace aluminum, and cast iron displace brass, in our fuses; and to change the form of our driving bands to economize copper. But everywhere again science has come to our aid once the need has been fairly put.

Production. Judging from our experience, the guiding rules in order to insure production would appear to be to develop to the utmost the production of what can be got easiest—remembering always that there will certainly be a demand for changes, and to press on research in the meantime so as to be ready to change to more efficient patterns as soon as the position allows of it, watching always the tactical changes so as to be able to anticipate demands. Thus the business man and the scientist have full fields for their activity, but both will have many discouragements to face, for in war they must be controlled by the needs of the soldier.

When the scientist after weeks of intense study has solved the secret of some wonderful idea for improvement in design, he will be told that it is not worth the loss of output it will entail; for to every change—however fascinating or desirable in itself—must be applied the touchstone "How much will it retard out-

put?" Just when the manufacturer is priding himself upon the introduction of improvements in method which will shortly double his output, he will be told to shut down.

So it is, and so it must be—*war is not, and never will be, a business proposition.*

Wear of guns. The output of new guns has not only to provide the numbers required to bring the army up to the desired strength, but it has to meet the wastage due to accident, to the enemy's fire, and to wear, of which the last completely overshadows the other two.

As long ago as 1916, General Gossot said in my hearing "Up to this the guns have eaten up shells; we shall now see the shells eat the guns." He was absolutely right. At the beginning we had little anxiety, for so admirable was the material of which our guns were made that their lives proved in practice to be far longer than had ever been anticipated. But as the output of ammunition increased they began to give out, and it may interest you to have some figures as to what the "lives" of the more important natures are. [Tables were presented showing the average life of guns and howitzers].

Needless to say that the search for a cure has been pursued with vigor, and this is a matter in which there is a great field for science; a field which has not been overlooked in this country, as witness the learned paper on the subject by Dr. Howe in the *Transactions of the American Institute of Mining Engineers* of last February. There is no doubt that the intense heat caused by prolonged rapid fire has brought on the guns a strain which was never anticipated, and in France and Russia and Italy I found that deterioration in the quality of the steel used since the war began was thought to have been a contributing cause. With us this latter does not appear to have been the case, except perhaps in individual instances, nor have we been able to determine whether carbon, nickel, or nickel-chrome steel gives the best results.

Reduced charges have now been introduced. Strict rules as to pauses to cool the guns have been promulgated, and various substances are now used for greasing the bore. We hope to get

good results from our latest mixture, the composition of which has, needless to say, been communicated to your ordnance authorities.

Repair of guns. But all the above are merely palliatives. We have to face the fact that our guns have all a very limited life under modern conditions. One battle may be enough for some, and so the question of *repair* has become one of great and growing importance. Facility for relining must ever be in the mind of the designer, the provision of sufficient plant for repair must be included in the outfit for war, and a regular system of withdrawal in rotation instituted. Just as in a fleet some ships must always be in dock if the docks are not to be congested by a sudden rush, so must a regular system of sending guns for relining be maintained.

With the ocean between your guns and your arsenals, the problem is a very difficult one for you.

Wear of carriages. And the same thing applies to the carriages. The delicate mechanism which is an essential feature of a modern carriage, even in field artillery, requires skilled and careful handling, especially when called upon for such a strain as is imposed by long continued rapid fire, with its consequent heating of all the parts, expansion of oil in the buffers, and so forth. It has always been the boast of artillery officers to know and care for their equipments, but the entry into action of large bodies of newly-raised artillery in 1916, synchronizing as it did with the enormous development in ammunition supply, undoubtedly led to a considerable amount of preventable damage. Where this struck us particularly was in the springs of our field carriages, and in the air recuperators of some of our heavier mountings. One divisional artillery commander told me in August that his guns had fired 7,500 rounds in six weeks, and that since the beginning of the action he had had on an average 25 per cent of his guns always out of action from this cause. All the spring-makers in England were called into conclave—representatives of the design departments of all the great gun making firms were taken over to France, to see on the spot where the failures were. But no doubt the chief damage was due to

the fact that in the heat of battle, inexperienced personnel had forgotten the constant attention buffers require. Great attention has since been paid to this part of the training, and after visiting many of the field workshops a few days after the commencement of the attack in Flanders, I was able to report that preventable damage was practically dead. But there are still, alas, some cases of prematures, and with the counter battery work that goes on now many cases of damage from the enemy's fire, so that our field workshops are still kept busy. Close up to the front you will find everywhere installed in ruined farms or under a tarpaulin shelter these ordnance workshops, containing a heterogeneous collection of damaged guns and carriages. From thestore of "spares" it may be possible to put the damage right with some adjustment, or from three such "lame ducks" it may be possible for one or two to be made complete, and so the work goes on all night, and by dawn the guns are in their places in the line again. The work done by the officers and men who man these workshops is a very material factor in the great artillery struggle, but nothing can compensate for the daily care of the gunners, and I always think the mottoes inscribed on the French 155-mm. Filloux guns should be on every gunner's heart:

"Le Canon bien tendu en vaut deux." "Soyez bons pour les freins."

I hope, gentlemen, that you will not think I have devoted too much of your time to this subject of production and repair, but it is one of absolutely vital importance to the efficiency of an army in the field, and it is one in which science has a great part to play.

Accuracy of fire. I had intended to tell you something of the development of the work of artillery in the field, of counter battery work, and of the "barrage," a word which seems to have captured the American imagination almost as much as "camouflage." But time does not permit, so I will confine myself as far as work in the field is concerned to giving you an idea of what has been done in the way of developing the *accuracy* of artillery fire during the war.

Accuracy of fire is of course the first essential to success in the artillery, and the first thing therefore that the good gunner does is

to get as good a platform for his gun as he possibly can, and that probably means much heavy labor in digging deep, and gathering material—rubble, bricks, timber—from a distance. This search for materials sometimes leads to amusing scenes.

Care of ammunition. But however solidly a gun may be supported it can not be expected to give uniform results unless the ammunition is in good order. Powder and fuses must be protected from the weather, and this entails much labor and constant care. We had, for instance, great trouble when we first adopted nitro-cellulose powder because we did not realize how sensitive it was to damp.

Protection from the weather is not, however, all that has to be done to insure good shooting from the ammunition. Cartridges and fuses are made in *lots*, and no "adjustment" can quite get over the differences between these. Every effort is made to keep lots together, and the system of doing so is at this moment being greatly developed, but even with all possible care, lots will inevitably get mixed in their passage from the factory to the ship, from the ship to the depots, from these to the dumps, and so through the various échelons of supply till they reach the guns. Cartridges and fuses must therefore be sorted in the batteries, and the necessary allowances made when using the different lots. Somewhat the same thing has to be done with the shell, for when a large output of ammunition is to be obtained from all sorts of factories it is out of the question to reject all which are not exactly within the strict limits of weight. They are accepted but with the weight marked upon them, and these again must be sorted and the necessary allowances made.

Calibration of guns. The next thing the artilleryman has to think of is the age of his gun, or rather how hard it has lived! As a gun wears, its accuracy and its range fall off. The former can not be calculated, though it must be allowed for; the latter can, and the loss of muzzle velocity in each gun must be found and allowed for. This is what we call "calibration," and it has to be repeated with each propellant, and, in a howitzer, with each charge. It is usually carried out on the front, because we prefer, whenever possible, that every shell should have at any rate a

chance of killing a German. To enable it to be done the topographical sections provide batteries with maps, mounted so as to avoid errors due to shrinkage or warping, and showing accurately not only the positions of the guns and observing stations, but also such datum points as may be desired in the enemy's lines.

Error of the day. Having by this means found the errors of the guns, a battery commander has next to think of the error of the day, or rather of the moment. He must ascertain and allow for the height of the barometer, the temperature of the air, the temperature of the charge, and the force and direction of the wind for a given time of flight, and here he has to depend on his scientific friend "Meteor" who sends to him every few hours cryptic telegrams.

Error of the gun. And yet after all this meticulous care, we have to recognize that a series of rounds fired at the same elevation will not fall on the same spot, but will cover a rectangle varying in size with the gun and the range. The size of the "50 per cent zone"—the length and breadth of which are a quarter of those of the 100 per cent zone—is given in the range table of each gun, and this has to be continually in the mind of the battery commander, for without a thorough realization of it he can not judge how many rounds will be required to accomplish such a task as, for instance, the destruction of an enemy's battery. But its most important use is perhaps to avoid danger of shelling one's own troops. Nothing is so distressing to an artillery general as to receive complaints from the infantry that his shells are falling in their trenches, and yet whatever the skill of his batteries this must happen sometimes, with the lines as close together as they are, unless this inherent quality in the gun is recognized and allowed for.

Difficulty of applying calculations in the field. I will not pursue the subject further, but remember that though the calculations may appear very simple to you, they are not so easy, given the conditions under which they have to be made—the absence of any conveniences, the presence of every disturbing element. It is very easy then to make an error which may have fatal results. One of my best battery commanders was killed by a shell from his own battery when himself conducting the fire from a trench from which he had cleared the infantry.

Observation of fire. But however confident he may be of the accuracy of the information furnished to him by his scientific assistants, and of the correctness of his own calculations, the good artilleryman will always do everything in his power to insure his fire being *observed*. The possibility of sending artillery officers forward with the advancing infantry had been hotly debated before the war and in some cases practised as far as this could be done in peace, so it did not take long to fall into the idea when the first halt on the Aisne gave the opportunity—and the demands that the work made on the enterprise and ingenuity of our officers caused it to be taken up with enthusiasm. The following example may bring home to you some idea of what this meant.

At one point on the Western Front there was a low ridge between the opposing front lines of trenches. Beyond the end of this ridge there was an offset in both lines. There were ammunition dumps behind the ridge, and beyond the offset stood the ruins of a farm-house, from which a good view could be had of the German positions behind the ridge. One of our battery commanders discovered that he could get up to that farmhouse at night. He went up one night and explored it and found that there was a gable still standing, and that the end of the gable had been knocked out by a shell, but that there were strips of drying tobacco hanging in the opening which he thought would give him shelter. So he got his telephone up there the next day, after many difficulties; he was only about 150 yards from the German lines. There he carried out a shoot which is a good instance of what I said about the importance of accuracy. Here was the ridge, and our trenches were just short of the crest. He wanted to shoot at the point beyond the crest. It was extremely difficult from the gunner's point of view to get a shell which would clear this crest and hit the objectives desired, for there was danger that the shell would hit the crest or drop into our own trenches. He succeeded through his control of the fire by direct observation, although he had to carry all that out in a place where he could not move and where he was really in full view of the Germans within almost pistol range. It was one of the sort of problems that artillery officers are continually attacking and solving in this war.

Aeroplane observation. Almost simultaneously the aeroplane observer entered the field. The story of how the present system of communication between aeroplanes and artillery has been gradually developed is in itself a subject for a lecture. Now not only does the observer in the air observe our fire, he also proves the correctness of his observation by bringing in a photograph of the result, which is used also by comparison with the zone of the guns to check the accuracy of the work of the battery. I need hardly refer to the science that has been devoted to developing the means of communication and prefecting the system, but all those who have had real experience, whether they belong to the Flying Corps or the Artillery, will I am sure agree that success will never be attained without the closest possible personal touch and sympathy between the observer in the air and the gunner below. They must know each other—without the personal equation, half the benefit of science is lost.

But practical experience showed the danger of relying too exclusively on aeroplane observation as liable to be put out of action by bad weather, while in any case the number of machines which can work on any given front is strictly limited. Great efforts are now therefore being made to develop all other possible means of observation. The balloon—the first cousin to the aeroplane—is of course very restricted in its zone, but it has the great advantage that the observer in it is in direct telephonic communication with the artillery—indeed it is nothing but an observing station in the air, which can be occupied by any artillery officer.

Observing stations. The ordinary observing stations have been developed in the one direction by camouflage which was first directed to this end, rather than to the concealment of the guns themselves; then to their elaboration—instead of the officer covering behind his precarious screen of tobacco leaves, he would be in a comfortable splinter-proof tower which had been ingeniously built inside the ruins; or sitting in the cellar, with his eye to a giant periscope, or perhaps a camera obscura.

Flash-spotting and sound-ranging. In the elaborately equipped observatories of the "flash spotters" the burst of every round may

be accurately recorded by the intersections of three widely separated observers, and instantaneously transmitted to the plotting stations. There too will be registered the position of any gun that is foolish enough to open fire from an insufficiently masked position when the clouds are dark behind it.

Then the "sound ranger" too plays his part, as with his delicate instruments he registers the discharge of the enemy's gun,—also, often enough, the burst of the enemy's shells. Their work must be done far to the front, and often with little or no protection, and I would like to bear witness to the gallantry of the distinguished savants who have let no consideration of personal safety or comfort interfere with the accuracy of their observations.

Gentlemen, I commenced by making one confession—that I had no information to give you about the new German gun, and I must conclude on the same note, for I am not going to attempt to say anything about what is by far the most interesting scientific development of artillery during the war—I mean anti-aircraft gunnery. The study of the ballistics of shell fired at such angles, the effect of high altitudes on the burning of the fuses, the invention of the wonderful instruments in the way of height-finders and so forth required for the direction of the fire, have opened up entirely new fields of scientific research. I have just had the pleasure of handing to your experts the results of a series of very exhaustive experiments which have been conducted in England. But it is wise to recognize one's own limitations; I very soon discovered that anti-aircraft gunnery had reached an atmosphere too rarified for me. You must therefore find younger and more scientific brains to tell you the wonders of the new science still in its infancy, but progressing by leaps and bounds. If you think that the results attained have been small, that with all the expenditure of talent and material devoted to it the proportion of aeroplanes brought to bag is insignificant, you must remember the difficulties of the task. An aeroplane covers more than half a mile while the shell is in the air, and I leave it to the sportsmen among you to say how many ducks they would pick up under such conditions.

Gas shell, the other great real novelty in artillery, has already been ably dealt with by my friend Major Auld, with whom "over

there" I have so often discussed their development and effect. There are indeed some other directions in which science is, I hope, even now on the threshold of discoveries, which if they will not "revolutionize warfare" will at least greatly increase the power of the artillery. A famous speaker is credited with the advice to a beginner, that if he could not be interesting he could at any rate always be indiscreet. But in war time one is denied even this resource. And so I am afraid that my contribution to your series of lectures on science in relation to the war has been a story of gradual development rather than of sensational advances. Even so, I hope that I have been able to show you that we artillerymen have maintained our traditional interest in science, and that it is not in vain that the famous statue of "Armed Science" has been for so many years the presiding genius of our mess room at Woolwich. I have shown you also a little of what men of science have done for us not only in the study but in the field. I am sure that you will come forward as freely, and that my brother officers of the American artillery will welcome as we have done all the assistance that science can give them.

CRYSTALLOGRAPHY.—*Certain relations between crystalline form, chemical constitution, and optical properties in organic compounds,—II.*[6] EDGAR T. WHERRY, Bureau of Chemistry.

Penta-erythrite

$C(CH_2OH)_4$ Ditetragonal-pyramidal; $a : c = 1 : 1.024$.

The optical data given by Groth[7] are tabulated here in the same manner as were those of urea. (See table 4, p. 321.)

The refraction and axial ratios agree within the limits of error of measurement, so in this substance, as in urea, the standard axial ratio is also the true one.

The chemical molecule of penta-erythrite can be brought into agreement with the observed symmetry if spread out around a central carbon atom with all the OH groups pointing in one direc-

[6] Continued from page 285.

[7] Chemische Krystallographie III: 385. 1910.

tion, bringing out thereby the lack of a horizontal symmetry plane. The space-lattice shows cube-centered arrangement within the smallest cells, as well as in the whole structure. These features are incorporated into figure 2.

As this substance possesses a rather complicated space-lattice, certain simplifications are introduced, such as the grouping of the H atoms and the OH radicals. In addition, the symbols are

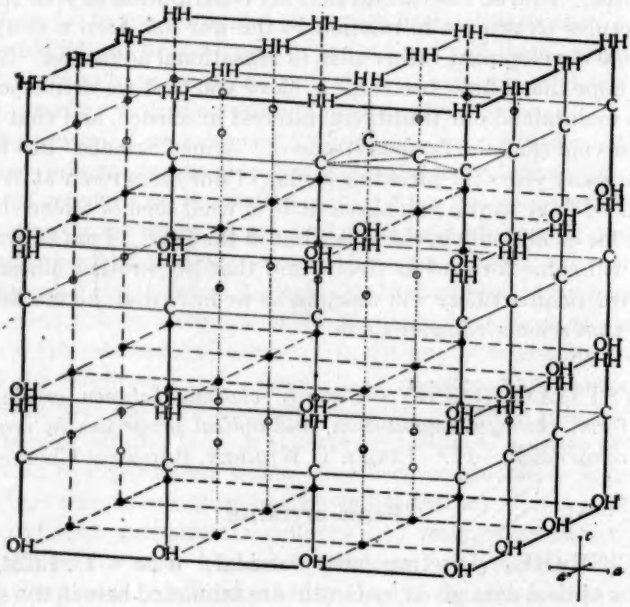

Fig. 2. Partial space-lattice of penta-erythrite.

given only for atoms that occur on the surface, except in the upper right forward cell, which is labeled completely; it is understood that all the points in any one horizontal plane indicated by dots or rings are occupied by the same atoms or groups that occur where the planes reach the front of the diagram. The space-lattice shown should be increased one-third in each horizontal direction to attain completeness. It will then contain 11 chemical molecules and $8^3 = 512$ of the smallest cells, and the

spacing of the cells can be determined by applying the same formula as was used for urea. Here x = 11, W = 135.02, m = 1.64×10^{-24} gm., y = 512, ρ = 1.40, c = 1.024. Solving, d_a = 1.49×10^{-8} cm., and d_c = 1.52×10^{-8} cm. The arrangement is too complicated for this to be interpreted in terms of the thick-

TABLE 4

REFRACTION RELATIONS OF PENTA-ERYTHRITE

REFRACTIVE INDICES		REFRACTION RATIO	AXIAL RATIO
ω	ϵ	R_ω / R_ϵ	c/a
1.559	1.548	1.0 7	1.024

ness of any one kind of atoms, but the values are not far from those of urea in the direction in which hydrogen layers appear, indicating that the spaces occupied by the several kinds of atoms in the two substances are about the same.

Mellite

$Al_2(C.COO)_6.18H_2O$ Ditetragonal-bipyramidal; $a:c = 1:0.746$.

If the alternate axial ratio of this peculiar mineral is used, the axial and refraction ratios show approximate inverse agreement, as brought out in table 5.

TABLE 5

REFRACTION RELATIONS OF MELLITE

REFRACTIVE INDICES		REFRACTION RATIO	AXIAL RATIO
ω	ϵ	R_ω / R_ϵ	c/a
1.539	1.511	1.046	1.055

In this substance complete working out of the space-lattice is impracticable, as the dispositions of the atoms in the organic radicals are uncertain. But the partial structure shown in figure 3 has several points of interest. In it R stands for (C.COO) and the heavy dots for H_2O. The fact that a compound in which certain groups appear in threes or multiples of three should crystallize tetragonal seems at first sight anomalous; but when

the number of atoms represented in a square occupied at both corners and centers of edges is figured out, it is found to be three; or if the atoms are moved from the corners part way toward the center—in the figure they are half way—, six prove to be present. The latter arrangement seems to fill the requirements in the present case the best.

The R groups are regarded, then, as lying in planes, with the Al atoms arranged, as required by the symmetry, along the verti-

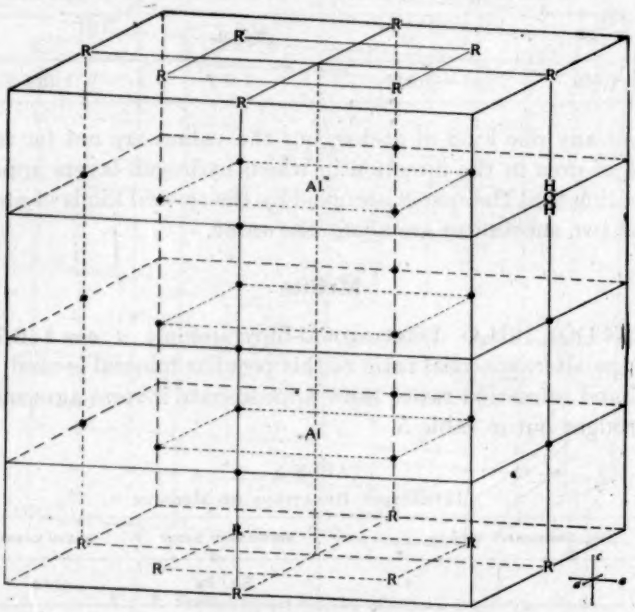

Fig. 3. Space-lattice of mellite.

cal axis between them. A sort of spool-shaped structure is thereby produced, and it is only natural that water of crystallization should, as it were, take the place of the thread. The 18 molecules of this can best be arranged in three layers of six each.

If the atoms of the (C.COO) group are actually spread out in the same vertical layers, occupying nodes where these intersect

horizontal ones shown, the spacing of the planes of the layers may be calculated in the usual way. In mellite x = 1, W = 62.95, m = 1.64×10^{-24}, y = 64, ρ = 1.64, and c' = 1.055, whence $d_a = 2.10 \times 10^{-8}$ and $d_c = 2.22 \times 10^{-8}$ cm. The somewhat greater values obtained in this case are what would be anticipated from the presence of the relatively large aluminium atoms, although the structure is too complicated and too uncertain for exact valuation of the effects of the several atoms.

The double propionate group.

The crystallographic and optical data in the literature[8] upon the double propionates of calcium with strontium, barium, and

TABLE 6

REFRACTION RELATIONS OF DOUBLE PROPIONATES

METALS	REFRACTIVE INDICES		REFRACTION RATIOS	AXIAL RATIOS
	ω	ϵ	R_ω / R_ϵ	c/a
Ca_2Sr	1.487	1.496	0.984	0.976
Ca_2Pb	1.526	1.540	0.978	0.979
Ca_2(Pb, Ba)	1.510	1.522	0.981	0.981
	1.485	1.498	0.978	0.986
	1.457	1.457	1.000	1.000
Ca_2Ba	1.444	1.444	1.000	1.000

lead respectively, show fair inverse agreement to exist between their crystallographic-axial and refraction ratios, as brought out in table 6. The barium salt is cubic, but this may be looked upon as a limiting case of the tetragonal system, where axis c = 1, and the refraction ratio is of course also 1.

The refractive indices and axial ratios have been accurately determined for a large number of isomorphous mixtures of the lead and barium salts; three of these are here listed as typical. Toward either end of the series the refraction and axial ratios show inverse agreement, but they deviate through the middle portion. Evidently the irregularities in the layers of atoms that

[8] GROTH, op. cit., p. 203.

result when large numbers of both barium and lead atoms are present disturb the refraction effects of the layers in which they lie in one direction, whereas when atoms of one kind are in considerable excess the layers, as it were, smooth out, and their effect on the refraction is normal.

One of several possible interpretations of the structure of these salts is shown in figure 4. It is easy enough to arrange two metal

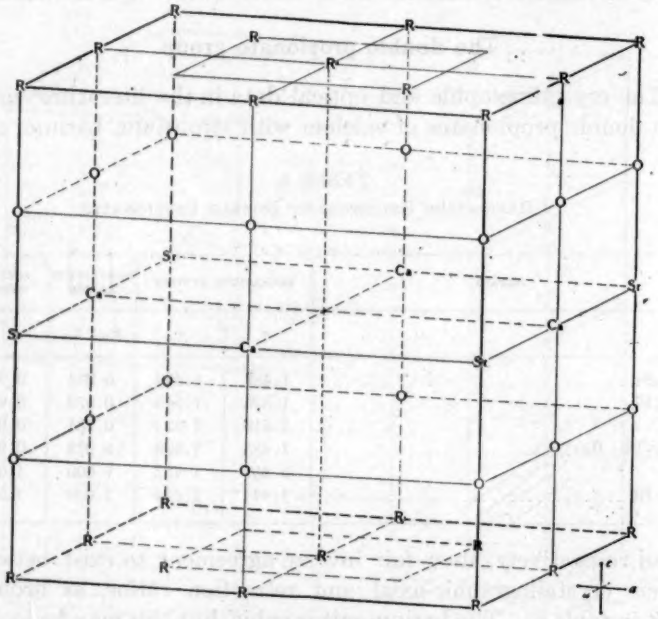

Fig. 4. Space-lattice of Ca-Sr propionate.

atoms of one kind and one of another kind into a group with tetragonal symmetry—the latter may occupy the corners of a square, the former the centers of its edges (only $\frac{1}{2}$ of the first and $\frac{1}{4}$ of the second belonging to the square). But the propionic acid radical $CH_3.CH_2.CO$ is rather clumsy to handle in a space-lattice. The mean positions it probably occupies are indicated

by R in the figure, but speculation as to the arrangement of the atoms within this group seems profitless.

Exceptions

It now seemed desirable to inquire into the relations in cases where inverse proportionality of the axes and the refractions fails to hold, and five illustrations of this were found among the 50 representatives of the tetragonal system listed by Groth,[9] namely: calcium-cupric acetate, ammonium-uranyl acetate, *i*-erythrite, β-methyl-glucoside, and guanidine carbonate.

In calcium-cupric acetate the inverse refraction ratio is 1.088 and the standard axial ratio 1.032. These are apparently too far apart for observational errors to cause their divergence, so it is concluded that in this substance either the atoms are irregularly arranged in one direction, or that a marked anisotropism of the copper atoms is associated with the coloring and pleochroism of the substance.

In ammonium-uranyl acetate the inverse refraction ratio is 0.979, and the standard axial ratio 1.412. If the form usually called (102) is made (111), the latter ratio becomes 0.998, approaching the former one. Probably some layers of atoms have no effect in fixing the position of the prominent form (111) on which the standard axial ratio is based, and yet their existence finds expression in the appearance of the subordinate form known as (102). The crystallographic measurements of this substance made by different observers vary nearly one degree, which may explain the lack of more exact agreement; and moreover some anisotropism of the uranium atoms is probably present as well.

In *i*-erythrite the inverse refraction ratio is 1.037, the standard axial ratio 0.376; but if the form taken as (111) is really (102) the latter ratio would be 1.068, which is nearer, yet still not identical with, the refraction ratio. However, the substance must possess a rather complicated structure, containing two asymmetric

[9] Chemische Krystallographie III (also a few in I and II).

carbon atoms, which are no doubt anisotropic; a deviation of the two ratios is thus not unexpected.

In the case of β-methyl-glucoside the situation is similar to the preceding. Here, however, the change needed in the standard axial ratio is merely the use of the alternate value for *c*, and the tabular habit and basal cleavage point to the fundamental correctness of this value, for in accordance with Fedorov's principle *c* should exceed *a* in such circumstances. The ratios are then: refraction, 1.035; crystallographic, 1.137. The complication of the structure, and the presence of several asymmetric carbons, are probably sufficient explanation of the divergence.

In guanidine carbonate the refraction ratio is 1.020, while the standard axial is 0.991. The numerical deviation is not very great, but is remarkable because the two lie on opposite sides of unity. However, crystals of this substance exhibit rotation of the plane of polarized light and abnormal dispersion of double refraction—showing a minimum around 589 and increasing both directions therefrom—, thus offering evidence of possible reasons for the above unusual relation.

The exceptions to the inverse relation of refraction and crystallographic axial ratios are thus readily explainable, although no data are as yet available that would permit the evaluation of the disturbance caused by each of the several factors which may be represented.

Preliminary observations have also been made on several other organic compounds that possess simple formulas and crystallize in fairly symmetrical systems and classes, comprising oxalic acid, iodoform, acetamide, both stable and unstable forms, and aldehyde-ammonia. For various reasons the measurements of the indices which it has thus far been possible to make are not particularly accurate, and although simple numerical relations appear to exist between the crystallographic and refraction ratios in many instances, the details of the structures are so complicated that no satisfactory space-lattices have yet been worked out. Further study of these and other compounds is planned, however, and will be reported from time to time as definite results are obtained.

SUMMARY

In this paper the study of the "refraction ratios" of crystallized organic compounds is suggested, these ratios being obtained by substituting in the standard refractivity formula the refractive indices exhibited in different directions. It is pointed out that these ratios as well as the crystallographic axial ratios are connected with the spacing of the planes of atoms in the space-lattices of the substances, and that comparison of the two ratios may be expected to throw considerable light on the type of space-lattice represented in each case. Such a comparison is made for the substances urea, penta-erythrite, mellite, and three double propionates, and their refraction ratios prove to be the exact inverse of the crystallographic axial ratios. The relations in several other substances are also discussed, and deviations from inverse proportionality are shown to be connected with atomic anisotropism, asymmetry of carbon atoms, etc. Further work on other substances is planned.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*Resonance and ionization potentials for electrons in cadmium vapor.* P. D. FOOTE and J. T. TATE. Bur. Stand. Sci. Paper No. 317. Pp. 17. 1918.

The object of this investigation has been the determination of the resonance and ionization potentials for electrons in cadmium vapor. Resonance collision of the electron with the atom was observed at 3.88 volts and inelastic impact resulting in ionization was observed at 8.92 volts. The single line spectrum of cadmium is $\lambda = 3260.17$. If we substitute the frequency corresponding to this wave length in the relation $h\nu = eV$, where $h = 6.56.10^{-27}$ erg. sec., e the electronic charge, and V the resonance potential, we obtain $V = 3.79$ volts, in good agreement with the above. On the basis of Bohr's theory the ionization potential should be 8.97, in most excellent agreement with the experimentally determined value. P. D. F.

GEOCHEMISTRY.—*The ferrous iron content and magnetic susceptbility of some artificial and natural oxides of iron.* R. B. SOSMAN and J. C. HOSTETTER. Bull. Amer. Inst. Min. Eng. 907–931. June, 1917.

The percentage of ferrous iron and the relative magnetic susceptibility in powder form have been determined on a number of art fic al and natural oxides of iron. Artificial oxides made at 1100° and 1200° consist of a solid solution of Fe_3O_4 in Fe_2O_3. Their relative magnetic susceptibility is approximately proportional to their percentage of FeO, from Fe_2O_3 over to Fe_3O_4. The deviations may be partly accounted for by the effect of various factors, of which the fineness of grain of the powdered oxide is the most important, especially in the case of the more ferromagnetic members of the series. The colors of the powdered oxides depend both on their chemical composition and on their physical constitution, especially the fineness of grain.

In addition to the oxides whose susceptibility depends upon their content of FeO, there exists also a highly ferromagnetic form of Fe_2O_3, which appears to be rare in natural occurrence.

The natural iron-oxide minerals are similar to the artificial in that many are solid solutions of Fe_3O_4 in Fe_2O_3. Others are mixtures of Fe_3O_4 and Fe_2O_3. If the ferrous iron is not in solid solution or in magnetite admixture, the magnetic susceptibility falls below the normal.

Some natural oxides can be magnetically fractionated; and the less magnetic portions are found to deviate more widely from normal than the more magnetic. The cause of this deviation is not yet entirely clear.

Martite is a pseudomorph after magnetite, but its constituent granules or fibers consist usually of a solid solution of Fe_3O_4 in Fe_2O_3. The ferrous iron content and the magnetic susceptibility of the specimens examined suggest that they have been produced at temperatures considerably higher that atmospheric.

R. B. S.

GEOCHEMISTRY.—*Zonal growth in hematite, and its bearing on the origin of certain iron ores.* R. B. Sosman and J. C. Hostetter. Bull. Amer. Inst. Min. Eng. 933–943. June, 1917.

The powdered oxide from certain crystals of hematite from Elba contains considerable FeO and can also be fractionated magnetically. It is therefore not homogeneous, as would be the case if the crystal were a uniform solid solution throughout. Analyses and magnetic measurements on a cross-section of an Elba crystal showed that the magnetic susceptibility and percentage of FeO vary, not irregularly, but continuously, being highest at the base and lowest at the free-growing tip of the crystal. The crystal is therefore zoned with respect to its FeO content.

Since Fe_3O_4 goes into solid solution in Fe_2O_3, forming a single solid phase of varying composition and properties, a zonal distribution of FeO is to be expected in an oxide of iron depositing from a vapor or solution. The occurrence of such zonal growth indicates continuously changing conditions of temperature, pressure, and concentration during the formation of the crystals. Several ore deposits of contact-metamorphic origin show a zonal distribution of ferrous iron, probably arising from the same causes as the zoning of the single crystals.

R. B. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on April 29, 1918. Upon the recommendation of the special committee on the JOURNAL, it was decided to discontinue the lists of references which have been published in the JOURNAL from time to time, and to appoint a group of assistant editors to supplement the present editorial board of three members. The ACADEMY's membership in the American Metric Association was continued for the present year. Ten resident and five nonresident members were elected.

ROBERT B. SOSMAN, *Corresponding Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 583d regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 6, 1918; called to order at 8 p.m. by President ROSE; 37 persons present.

On recommendation of the Council, Miss CRYSTAL THOMPSON and Mr. NORMAN A. WOOD, both of the Museum of Zoology, Ann Arbor, Michigan, were elected to membership.

The following informal communications were presented;

W. L. MCATEE remarked on the contents of birds' stomachs and exhibited the stomach of a merganser containing an embedded fish hook, which undoubtedly had been in a swallowed fish.

Gen. T. E. WILCOX remarked that he had once found an Indian arrow head in the stomach of a grouse.

Dr. L. O. HOWARD called attention to efforts made to limit the spread of pink boll-worm by the establishment of cotton-free zones in Texas.

WILLIAM PALMER exhibited some fossil teeth and bones lately obtained by him from the Calvert Cliffs, near Chespeake Beach, Maryland: tooth of *Hexanchus primigenius;* fragment of bone of *Puffinus;* tooth of *Champsodelphis acutidens;* tooth of a sirenian; tooth of *Delphinodon,* n.s.; tooth of *Thinotherium annulatum.* His remarks were discussed by Dr. L. O. HOWARD and Capt. M. W. LYON, JR.

The regular program consisted of two communications;

C. D. MARSH: *The cause of milk sickness or trembles.* The first publication in regard to milk sickness was in 1810, but it had been known as far back as the Revolutionary War. The disease was especially common in the early days in the states of Ohio, Indiana, and Illinois, but has rarely been recognized in publications upon diseases as a disease with a

specific entity. The most noticeable symptoms are pronounced nausea, with vomiting, extreme constipation, and trembling. The disease was said to affect particularly cattle and was transmitted through the milk to human beings. A good deal of mystery has been attached to the etiology of the disease and among the suggestions as to the cause have been fungi, insect-borne germs, emanations from the soil, and a number of supposed poisonous plants. The plant to which suspicion has been particularly directed has been *Eupatorium urticaefolium*. commonly known as white snake root. The work of Jordan and Harris in 1909 seems to prove that the disease is produced by a distinct bacillus, and the publication of Crawford in 1908 seemed to negative the possibility of Eupatorium being the cause of the disease. It seemed best, however, on account of the suspicion which still attached to this plant for the Department of Agriculture to make a series of feeding experiments. These experiments proved conclusively that *Eupatorium urticaefolium* is poisonous to both cattle and sheep. The knowledge thus acquired in connection with other published statements seems to make it certain, not only that the Eupatorium is poisonous to both cattle and sheep, but that it is the cause of many, if not almost all of the so-called cases of milk sickness in cattle and sheep.

Dr. Marsh's paper was illustrated by lantern slides showing characteristic attitudes of poisoned animals.

J. W. GIDLEY: *Segregation an important factor in evolution with its special bearing on the origin and distribution of mammals.* (No abstract.)

Mr. Gidley's paper was discussed by Prof. BRADLEY M. DAVIS, Dr. T. S. PALMER, Mr. WILLIAM PALMER, and Capt. M. W. LYON, JR.

M. W. LYON, JR., *Recording Secretary.*

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 525th meeting of the Society was held in the Lecture Hall of the Public Library on Tuesday, April 9, at 8 p.m. Dr. PAUL HAUPT, W. W. Spence Professor of Semitic Languages and Director of the Oriental Seminary at Johns Hopkins University, Baltimore, Maryland, gave an address upon *Mesopotamia and Palestine.*

"The early civilization of Babylonia was Sumerian. The Sumerian language appears to be related to Georgian in Russian Transcaucasia. Mesopotamia passed successively under the sway of the Sumerians, Accadians, Hittites, Cassites, Assyrians, Chaldeans, Persians, Macedonians, Parthians, Romans, Sassanians, Arabs, Mongols, Tartars, and Turks. Since 1638 it has been a part of the Turkish Empire.

"In 1902 the Turkish Government granted to a German syndicate a charter for the construction of a railway from Constantinople through Asia Minor to Bagdad, and afterwards to Basra. This through line from Hamburg to the Persian Gulf, which threatened the British dominion of India, was one of the most important factors which led to the world war.

"In 1886 I recommended colonization of Mesopotamia, construction of the Euphrates Railway, and restoration of the ancient system of irrigation. In 1887 I prepared a memorandum concerning a national expedition to Mesopotamia under the auspices of the Smithsonian Institution. In 1892 I suggested settlement of the Russian Jews in Mesopotamia. My plan was afterward advocated by Israel Zangwill.[1] The restoration of the ancient system of irrigation, which would make Babylonia again the chief granary of the world, was taken up in 1909 by Sir William Willcocks.

"The relations between Mesopotamia and Palestine are very close. The ancestors of the Israelites came from Mesopotamia. The Israelites were settled in Palestine when the Edomite ancestors of the Jews were in Egypt. Judah was not a tribe but a religious association of worshippers of Jahveh, including not only Edomites, but also Horites, Canaanites, Ishmaelites, Moabites, Hittites, Amorites, Philistines, Egyptians, and Ethiopians, *i.e.*, a mixture of Asiatic, African, and European elements.

"It will perhaps be possible to solve the complicated ethnological problems in Palestine with the help of the new sero-diagnostic methods based on deviation of complement whereby the lytic action of a hemolysing fluid is prevented. Hansemann made some experiments with Egyptian mummies. Friedenthal tested the blood and flesh of a mammoth which had been found in 1902, imbedded in the ice of Siberia. The reaction showed the near relation of the extinct mammoth to the existing Indian elephant.

"Palestine (both Western and Eastern) is nearly as large (9840 sq. m.) as Sicily (9860 sq. m.), but it has only about 750,000 inhabitants, (Mesopotamia about 1,500,000). Like Sicily, which was the bridge between Europe and Africa, Palestine, the connecting link between Mesopotamia and Egypt, never was the land of a single nation and probably never will be. Certainly the Jews can claim only Judea, not the northern districts, Samaria and Galilee, or the country east of the Jordan. The majority of the colonists whom the Assyrian kings sent to Galilee were Aryans, *i.e.*, Iranians, so that the founders of Christianity may not have been Jews by race.

"With the passing away of anti-Semitism Jewish nationalism will disappear. The Jews in this country will be Americans, the Jews in France will be Frenchmen, but they will continue to regard Jerusalem as their spiritual mother."

The 39th annual meeting (526th regular meeting) of the Society was held in the West Study Room of the Public Library, April 23, at 8 p.m.; President BABCOCK in the chair. The following officers were elected for the ensuing year: *President*, Mr. E. T. WILLIAMS; *Vice-president*, Dr. TRUMAN MICHELSON; *Secretary*, Mr. FELIX NEUMANN; *Treasurer*, Mr. J. N. B. HEWITT; *Councillors*, Mr. J. P. HARRINGTON, Mr. FRANCIS

[1] See The American Hebrew, May 21, 1909.

LaFlesche, Rev. John M. Cooper, Dr. E. D. Morgan, Miss Frances Densmore. The society then listened to the address of the retiring president, Mr. W. H. Babcock, on *Some anthropological and national factors in the present war.*

The speaker reviewed the series of papers on national subjects which had been delivered before the society during the past year.

"The war is a contest of nations, conditions, and racial aspirations; between the central Teutonic empires, with originally Turanian adherents, and the surrounding republics or liberal monarchies, chiefly Latins, Slavs, and the English-speaking peoples. But the difference in kinds of government had less to do with beginning the war than the vehement hostility of races and national ambitions.

"A 'race' and 'nation' are variable terms. Language does not always accord with either. No people is homogeneous. What counts for most is a conviction of national identity and racial affiliation sustained emotionally by an ideal of patriotism. When this is violently overridden, a sense of outrage and sacrilege is evoked—the most fruitful source of devastating wars. The best preventive would be such political redistribution as would end alien oppression and make aggression very difficult."

The speaker sketched the human movements which have evolved and defined the peoples of Europe; also the special changes needed. The same victorious powers of civilization which must effect the latter could also maintain them. The prospect of a general and lasting peace was never so good as now; for the world is nearly full and well under control, excepting as yet the Central Powers and their auxiliaries. There would be no danger from outside barbarians, such as wrecked the long continued, but territorially restricted, dominion of Rome.

Frances Densmore, *Secretary.*

SCIENTIFIC NOTES AND NEWS

At the meeting of the National Academy of Sciences, held in Washington on April 22–24, 1918, the following fifteen persons were elected to membership: ROBERT GRANT AITKEN, astronomer, Lick Observatory, California; GEORGE FRANCIS ATKINSON, botanist, Cornell University, Ithaca, N. Y.; GEORGE DAVID BIRKHOFF, mathematician, Harvard University, Cambridge, Mass.; PERCY WILLIAMS BRIDGMAN, physicist, Harvard University, Cambridge, Mass.; STEPHEN ALFRED FORBES, zoologist, University of Illinois, Urbana, Ill.; JOHN RIPLEY FREEMAN, engineer, Providence, Rhode Island; LUDVIG HEKTOEN, pathologist, University of Chicago, Chicago, Ill.; CHARLES JUDSON HERRICK, neurologist, University of Chicago, Chicago, Ill.; FRANK BALDWIN JEWETT, engineer, Western Electric Company, New York, N. Y.; WALTER JONES, physiologist, Johns Hopkins University, Baltimore, Md.; IRVING LANGMUIR, chemist, General Electric Company, Schenectady, N. Y.; CHARLES ELWOOD MENDENHALL, physicist, University of Wisconsin, Madison, Wis.; JOHN CAMPBELL MERRIAM, paleontologist, University of California, Berkeley, Cal.; HENRY NORRIS RUSSELL, astronomer, Princeton University, Princeton, N. J.; DAVID WATSON TAYLOR, engineer, rear-admiral and chief of the bureau of construction and repair, United States Navy.

Prizes and medals were awarded as follows: The Comstock prize of $1500, for discoveries in magnetism and electricity, awarded to SAMUEL JACKSON BARNETT, Ohio State University, Columbus, Ohio.

The Draper medal, for discoveries in astronomical physics, awarded to WALTER SYDNEY ADAMS, Mount Wilson Solar Observatory, Pasadena, California.

The Daniel Giraud Elliot medal and honorarium for work in paleontology and zoology, awarded to FRANK M. CHAPMAN, American Museum of Natural History, New York.

A special train left Washington on Monday evening, April 29, carrying members of the American Electrochemical Society on a six days' trip through the Appalachian South, to visit some of the more important electrochemical, electro-thermal, and power developments in that part of the country.

Dr. W. L. ARGO, of the University of California, has been engaged in researches on gas masks at the Geophysical Laboratory and the Catholic University.

Dr. LOUIS A. BAUER has been elected Foreign Corresponding Member of the Royal Society of Natural Sciences of Netherlands India.

Mr. ALBERT BURCH, of the Bureau of Mines, and Mr. E. F. BURCHARD, of the Geological Survey, have recently returned from Cuba, where they went to ascertain the possibility of Cuba supplying a portion of the United States' requirements of manganese ore and chromite. They found that it is probable that Cuba will be able to furnish a portion of the manganese ore and chromite formerly imported from other foreign sources.

Mr. F. S. DURSTON, of the Bureau of Standards, has been commissioned a lieutenant in the U. S. Naval Reserve Forces.

Professor L. C. GRATON is on leave of absence from Harvard University and is in charge of the work of the Copper Producers' Committee in New York.

Professor F. R. MOULTON, of the University of Chicago, is in Washington on leave of absence and has been commissioned a major in the Ordnance Reserve Corps.

Professor KANOICHIRO SUIDZU, of the Department of Organic Chemistry, Tokyo Higher Technological College, visited Washington in April.

Professor DAVID G. THOMPSON, of Goucher College, Baltimore, is on leave of absence and spent the past summer on field work with the party of O. E. MEINZER, of the U. S. Geological Survey, locating and marking watering places in the deserts of the Southwest near the Mexican border.

Professor RICHARD C. TOLMAN, of the University of Illinois, is on leave of absence to do war research in Washington. He is temporarily stationed at the laboratories of the Catholic University.

News was received on April 18, 1918, that Captain ERNEST WEIBEL had died of wounds at a hospital in France. Captain Weibel became a member of the staff of the Bureau of Standards in 1910. He was commissioned a captain in the Engineers Corps after the declaration of war by the United States, and was soon afterward sent to France, where he was engaged in the sound-ranging service. He was a member of the Philosophical Society of Washington, and author of several papers in collaboration with F. WENNER and F. B. SILSBEE on time-constants and inductance of low-resistance standards, the use of the Thomson bridge, and the testing of potentiometers. He also published, in collaboration with A. L. THURAS, a paper in this JOURNAL of March 19, 1918, on *An electrical instrument for recording sea-water salinity.*

Dr. H. O. WOOD, formerly of the Hawaiian Volcano Observatory, has been commissioned a captain in the Engineer Officers' Reserve Corps and is engaged in special research work at the Bureau of Standards.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Surgeon General RUPERT BLUE, U. S. Public Health Service, Washington, D. C.

Professor HENRY EDWARD CRAMPTON, Barnard College, Columbia University, New York City.

Dr. HEINRICH HASSELBRING, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. GEORGE GRANT HEDGCOCK, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. GEORGE SAMUEL JAMIESON, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

Professor ARTHUR BECKET LAMB, Harvard College, Cambridge, Mass., and American University Experiment Station of the Bureau of Mines, Washington, D. C.

Mr. S. J. MAUCHLY, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C.

The Executive Committee of the Entomological Society of Washington has recently adopted the following rules and suggestions governing articles published in the *Proceedings of the Society:*

Rules

Rule 1. No description of a new genus, or subgenus, will be published unless there is cited as a genotype a species which is established in accordance with current practice of zoological nomenclature.

Rule 2. In all cases a new genus, or subgenus, must be characterized and if it is based on an undescribed species the two must be characterized separately.

Rule 3. No description of a species, subspecies, variety, or form will be published unless it is accompanied by a statement which includes the following information, where known: (1) the type locality; (2) of what the type material consists—with statement of sex, full data on localities, dates, collectors, etc.; (3) present location of type material.

Rule 4. No unsigned articles, or articles signed by pseudonyms or initials will be published.

Rule 5. The ordinal position of the group treated in any paper must be clearly given in the title or in parentheses following the title.

Suggestions

1. All illustrations, accompanying an article, should be mentioned in the text and preferably in places where the object illustrated is discussed.

It is desirable in describing new genera and species that their taxonomic relationship be discussed, and that distinguishing characters be pointed out.

3. In discussion of type material modern terms indicating its precise nature will be found useful. Examples of these terms are type (or holotype), allotype, paratype, cotype, lectotype, neotype, etc.

4. In all cases in the serial treatment of genera or species and where first used in general articles the authority for the species or genus should be given; and the name of the authority should not be abbreviated.

5. Where the title of any publication referred to is not written in full, standard abbreviations should be used.

6. When a species discussed has been determined by some one other than the author it is important that reference be made to the worker making the identification.

WAR ORGANIZATION OF THE NATIONAL RESEARCH COUNCIL

Because of the urgent necessity of improving means of dealing promptly and effectively with all problems bearing on the war, a reorganization of the National Research Council was effected on April 1, 1918, a summary of which follows.

The Executive Board has established eight divisions, each under the charge of a chairman who shall give all, or the greater part, of his time and attention to the affairs of his division, so as to be in a position to give immediate consideration to any problems which may arise. The following statement indicates the steps thus far taken.

Each of the eight divisions is to have an Executive Committee, to include members representing the several committees of the Council included within the Division. All of the former committees that are still active are retained under the new organization and additional committees will be established as the needs of the work may demand. The final organization of the Council may differ materially from the one indicated, both in the grouping of the various subjects into divisions and in the organization of sections and committees within the divisions.

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Division of Agriculture, Botany, and Zoology

VERNON KELLOGG, Chairman

RESEARCH INFORMATION COMMITTEE

The chief functions of the Washington office of the Research Information Committee have been defined as follows:

(a) To provide means of ready cooperation with the London and Paris offices of the Committee by:

1. Receiving, collating, and disseminating information forwarded from these offices.

2. Rendering available such evidence and documents as may be collected by the National Research Council relative to re-

search in the United States, so as to formulate replies to inquiries sent from abroad.

3. Communicating to foreign offices needs for additional information relating to problems originating in the United States.

(b) Classification, cataloging, and filing of papers and reports received from various sources at the request of the National Research Council, and record of researches in progress concerning which detailed information may be obtained elsewhere.

(c) Issue of lists of available information and preparation of digests of such information for distribution to properly accredited persons.

(d) Maintenance of contact with various research agencies in the United States.

BOOK